Slides to Accompany

General, Organic, and Biochemistry

Bettelheim

Slides prepared by Paul E. Fore

Biochemistry

Lipids

Chapter 20

Chapter 20 - Lipids

Insoluble in H_2O

Soluble in

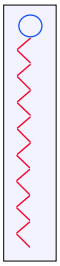
diethyl ether, methylene chloride

acetone, etc.

Most biomolecules are soluble in H_2O

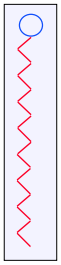
lipids are an important exception

cell membranes.



Lipids

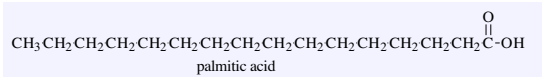
- Types of Lipids:
  1) Fats and waxes
  2)
  3)
  4)



Structure of Fats

- Fats are
- Alcohol part is always glycerol
- Acid part varies but is a "Fatty Acid"

also called "glycerin"



palmitic acid

a typical "fatty acid"

Structure of Fats

- Fatty Acids (FA)
  1) Practically all
  2) 10 to 20 C in length
  3) Contain an even number of

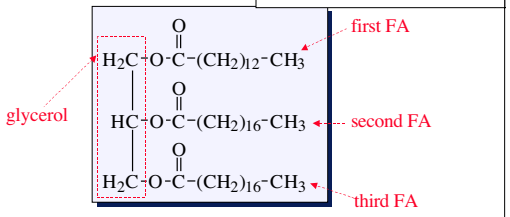
     The body builds FA from two carbon units of acetic acid (acetate ion)
  4) Only -COOH or C=C as functional groups

$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2C(=O)OH$

palmitic acid

Structure of Fats

- Fatty Acids + Glycerol =

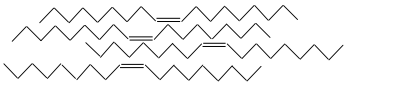


Structure of Fats

- FATS
  - Triglycerides
  - Also called Triacylglycerides
    - » diglycerides (two FA esterified w/ glycerol)
    - » monoglycerides (one FA esterified w/ glycerol)
  - Fats are insoluble in water
  - Both saturated and unsaturated FA

Structure of Fats

- FATS
  - Saturated Fatty Acids
    - »
    - »
  - Unsaturated Fatty Acids
    - » cis/trans double bonds do not allow regular packing
    - » LOWER mp and bp lower than the Sat'd. FA



Properties of Fats

- Physical State - FATS
  - Animal fats
    - » generally solids at
    - » contain mostly saturated FA
  - Plant and Fish oils
    - » generally liquids at
    - » contain more unsaturated FA

Properties of Fats

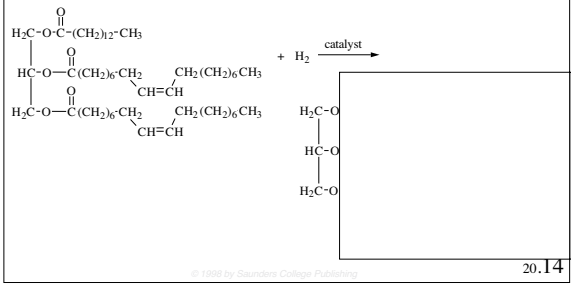
- Physical State - FATS
- Exception -
  - Saturated FA, but smaller chain
- PURE Fats
  - Colorless, odorless, and tasteless
  - Tastes, odors, colors are caused by substances dissolved in the fats

Hydrogenation

- Treatment with
- Catalyst required
- NOT difficult to convert unsaturated FA to saturated FA
- Called
- Margarine contains more unsaturation then than hydrogenated shortenings
  - Crisco, Spry, etc.

Hydrogenation

- Unsaturated converted to saturated:

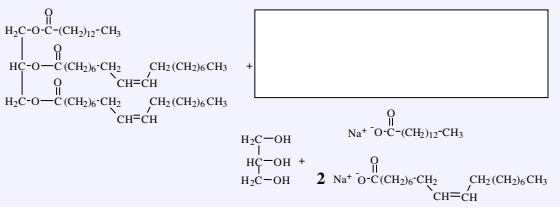


Saponification

- Triglycerides are subject to hydrolysis
  - Can be hydrolyzed with acid or base
  - Base hydrolysis is called "saponification"
  - Result of base hydrolysis is a SOAP
- SOAP
  - The mixture of sodium salts of Fatty Acids produced by

Saponification

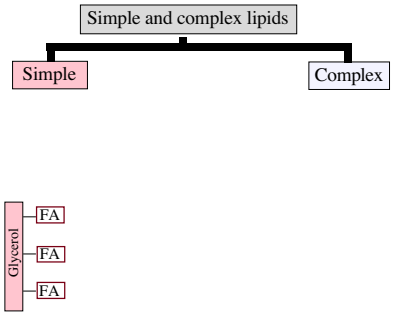
- Triglycerides are subject to hydrolysis
  - base hydrolysis is called "saponification"



Complex Lipids

- Complex Lipids
- Cell membranes made of complex lipids
  - Phospholipids = alcohol, FA, PO_4^{3-}
    - »
    - »
  - Glycolipids
    - » contain carbohydrates

Classification of Lipids



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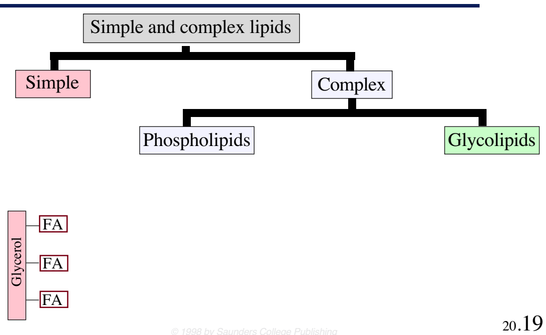

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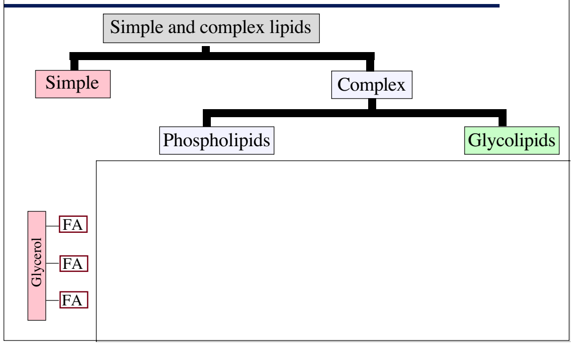
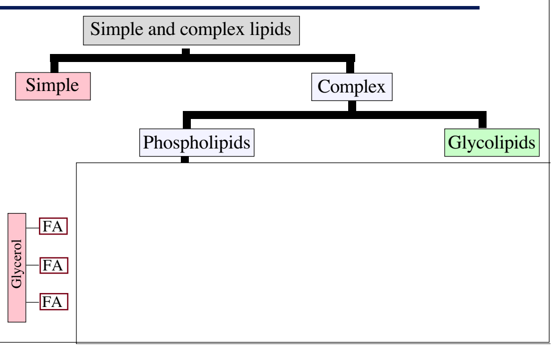
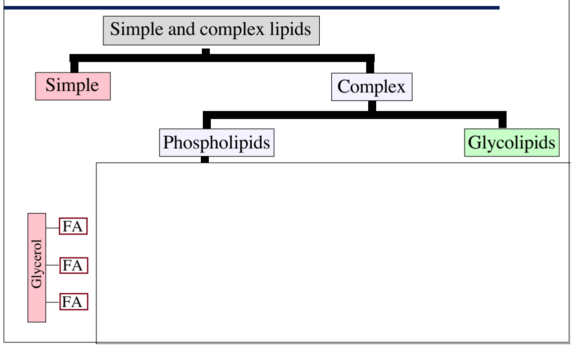
Classification of Lipids



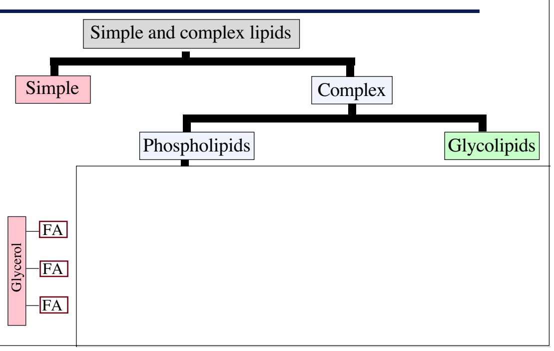
Classification of Lipids



Classification of Lipids

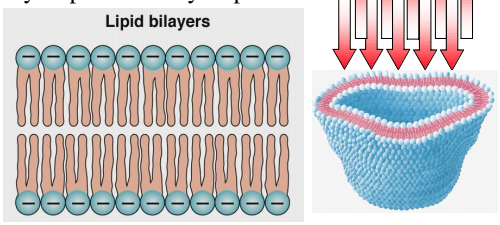


Classification of Lipids



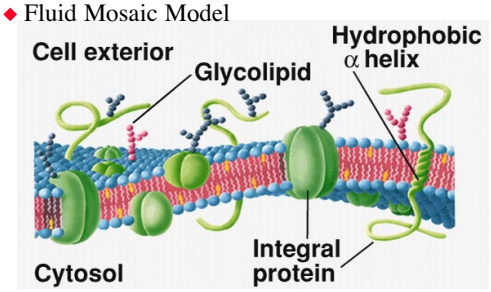
Membranes

- Complex Lipids make up membranes
- Hydrophilic vs. Hydrophobic



Membranes

- Fluid Mosaic Model



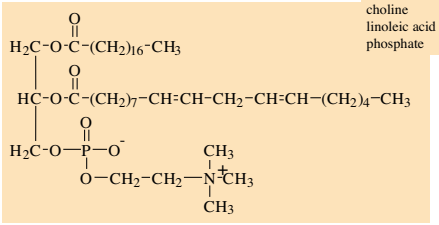
Glycerophospholipids

- Phosphoglycerides
- Glycerol is the alcohol
- Two acids are FA
- Third is esterified to PO_4^{3-} and choline

Glycerophospholipids

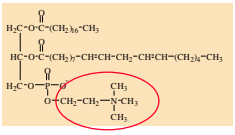
- Phosphotidylcholines
- Also called "lecithins"

Locate:
glycerol portion
stearic acid
choline
linoleic acid
phosphate



Glycerophospholipids

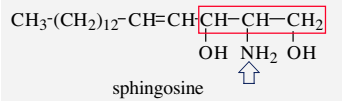
- Lecithins
  - Charged groups
  - Forms lipid bilayers
  - Hydrophobic heads together



- Cephalins
  -
  -

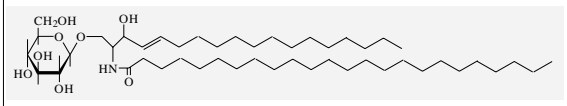
Sphingolipids

- Sphingolipids
- Coating of nerve axons (myelin)
- Alcohol portion is sphingosine
  - NH_2 with FA =
  - Stearic acid in sphingomyelin



Glycolipids

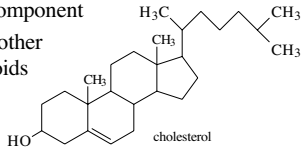
- Glycolipids contain carbohydrates
- One type is the cerebrosides
  - occur in the brain
  - present at nerve synapses



a glucocerebroside

Steroids

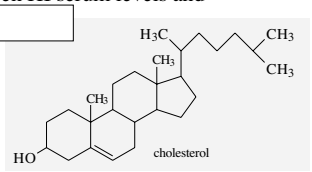
- A third major class of lipids:
  - Not necessarily esters
- Cholesterol
  - most abundant steroid in the body
  - cell membrane component
  - raw material for other synthesis of steroids



cholesterol

Cholesterol

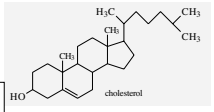
- Exists in both free and esterified forms
  - Esterifies with FA
  - Gallstones are almost pure cholesterol
  - Correlation between HI serum levels and
  - Necessary for human life



cholesterol

Cholesterol

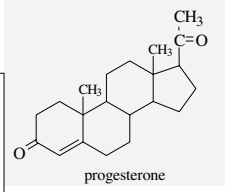
- Manufactured by liver
  - Transferred from liver to peripheral tissues
  - HDL =
    - » 50% protein
    - » transports cholesterol to liver
  - LDL = lo density lipoprotein
    - » 25% protein
    - » transfer cholesterol to cells
    - » if not enough LDL receptors,



cholesterol

Steroid Hormones

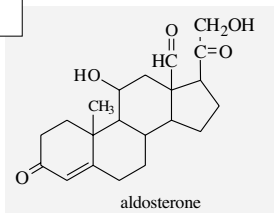
- Adrenocorticoid Hormones
  - Cholesterol is starting material for synthesis
  - Progesterone:
    - » Alcohol on C-3 converted to a ketone
    - » Side chain on D ring modified



progesterone

Steroid Hormones

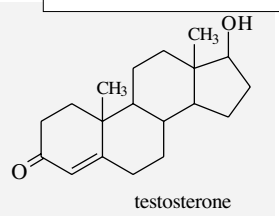
- Aldosterone
  - Product of the adrenal gland
  -
  - Increased secretion enhances reabsorption of Na^+ and Cl^- ions in the kidney tubules



aldosterone

Steroid Hormones

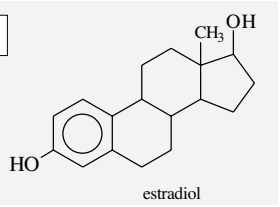
- Sex Hormones - Testosterone
  - Promotes normal growth of
  - Synthesized in testes from cholesterol
  - Secretion results in 2nd sex characteristics



testosterone

Steroid Hormones

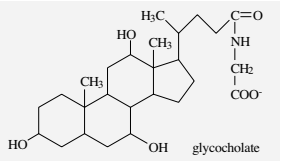
- Sex Hormones -
  - Regulates cyclic changes in the uterus
  - Synthesized from
  - Menstrual Cycle
    - » increased estradiol at beginning of cycle
    - » uterus thickens
    - » Luteinizing hormone triggers ovulation



estradiol

Bile Salts

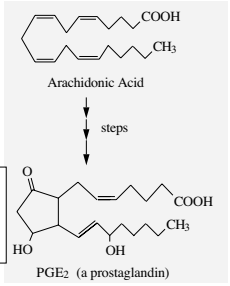
- Bile Salts are oxidation products of
- Charged salt is more soluble in solution
- Bile salts help disperse dietary lipids in the small intestine
- Remove cholesterol in two ways



glycocholate

Prostaglandins

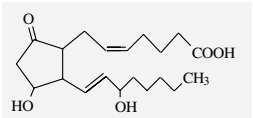
- Fatty acid-like substances
- Produced in prostate
  - small amounts produced in all tissue
- Synthesized from



PGE_2 (a prostaglandin)

Prostaglandins

- PGE_2
  - induce labor
  - therapeutic abortion
  - lowers bp
  - used to treat asthma

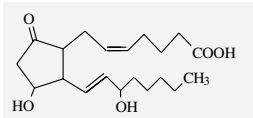


PGE_2 (a prostaglandin)

- $PGE_{2\alpha}$
  -
- PGE_1
  -

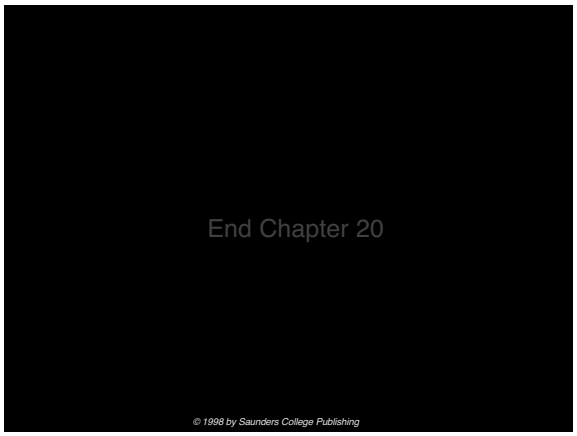
Prostaglandins / Leukotriene

- Prostaglandins
  - Cause inflammation and fever
  - Aspirin inhibits prostaglandin formation



PGE_2 (a prostaglandin)

- Leukotrienes
  - Occur mainly in leukocytes
  -
  -


End Chapter 20
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